vegetable food for three or four days, was bought, apparently in a hopeless state of starvation, by one of M. Godeffroy's collectors. He offered it some insects, which it eat readily, and on which diet it soon recovered its health. It was fed for a fortnight upon beetles, grubs, &c., and was thriving well; but, unfortunately, it escaped from its cage one day while it was being fed.

"The native name of the *Pareudiastes* is not *Punæ*, as given in the Society's 'Proceedings' for 1871 on the authority of Mr. Kubary, but *Puna'e*, best spelt for those unacquainted with the Samoan dialect, *Punahe*. It is found both on Upolu and Savaii, but is apparently more common on the latter island than on the former. I have never heard of it being seen except some distance inland amongst the mountains."

The following extract was read from a letter addressed to the Secretary by Dr. G. Bennett, F.Z.S., dated Sydney, January 16th, 1874:—

"On the 7th inst. I received a letter from the Rev. Mr. Whitmee, dated Samoa, South Pacific, December 15th, 1873, in which he says, 'I take the liberty of sending to your care, to be transmitted to the Zoological Society of London, one living *Didunculus strigirostris* and two Quiros-Island Curlews. The *Didunculus* is a young bird which I had unfledged from the nest, and eats ravenously almost any thing of the vegetable order. The Curlews also have long been accustomed to vegetable food. They may all be fed on rice, biscuits, &c. on board a ship.'

"These birds arrived in excellent health and condition and continue so to the present day. I have them at my home under Mrs. Bennett's care, which I considered would be better than sending them to the Aviary in the Gardens; and fortunately Broughton is in Sydney in the 'Paramatta,' and I shall request him to take charge of them for you.

"The 'Paramatta' will leave for England early in February."

Dr. A. Günther, F.R.S., made some remarks on the introduction of the Ide (*Leuciscus melanotus*, var. *orfus*) into this country.

The following papers were read:—

1. On the Structure of the Skull and of the Heart of *Menobranchus lateralis*. By T. H. Huxley, Sec.R.S.

[Received March 17, 1874.]

(Plates XXIX.–XXXII.)

I. *The Skull.*

In 1835, Mayer, in his 'Analecten für vergleichende Anatomie,' published a brief account of the anatomy of *Menobranchus lateralis*. Under the head of "Osteologie" (p. 82), he remarks:—

"The skull has a singular form, which results from the brevity of the mandible and the direction of the long quadrate bone obliquely

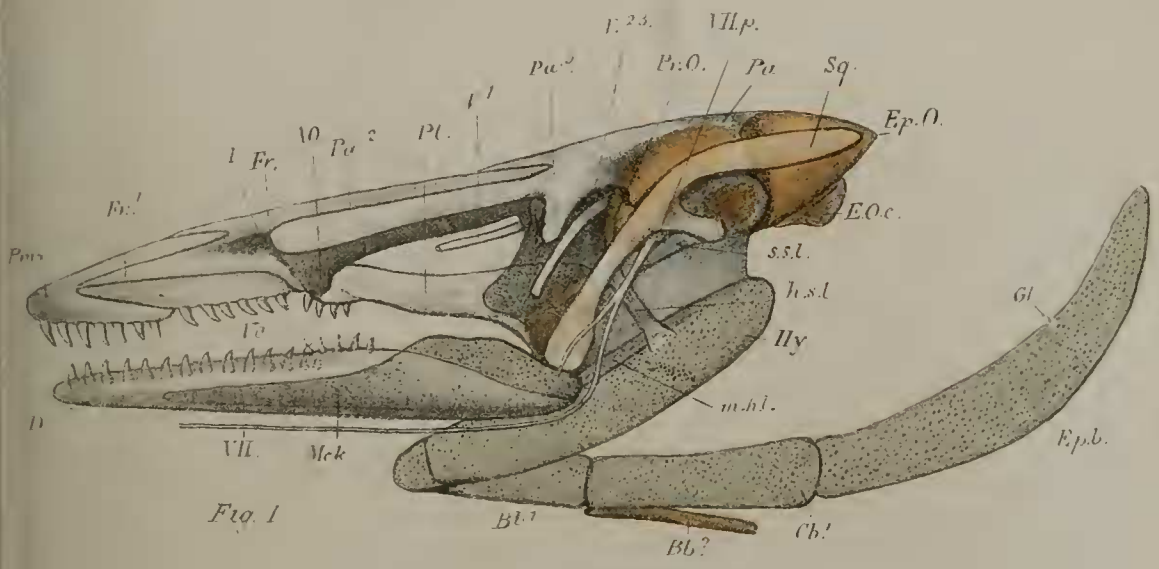

Fig. 1

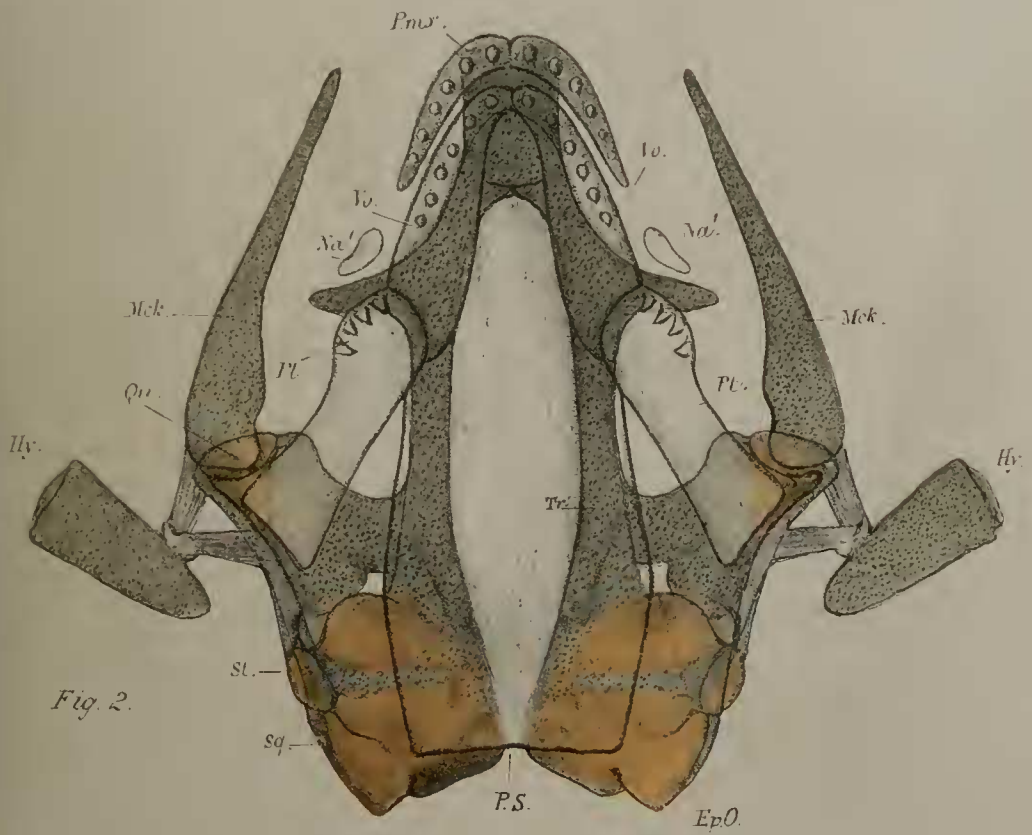

Fig. 2.

W.H.Wesley lith.

M&N Hanhart imp

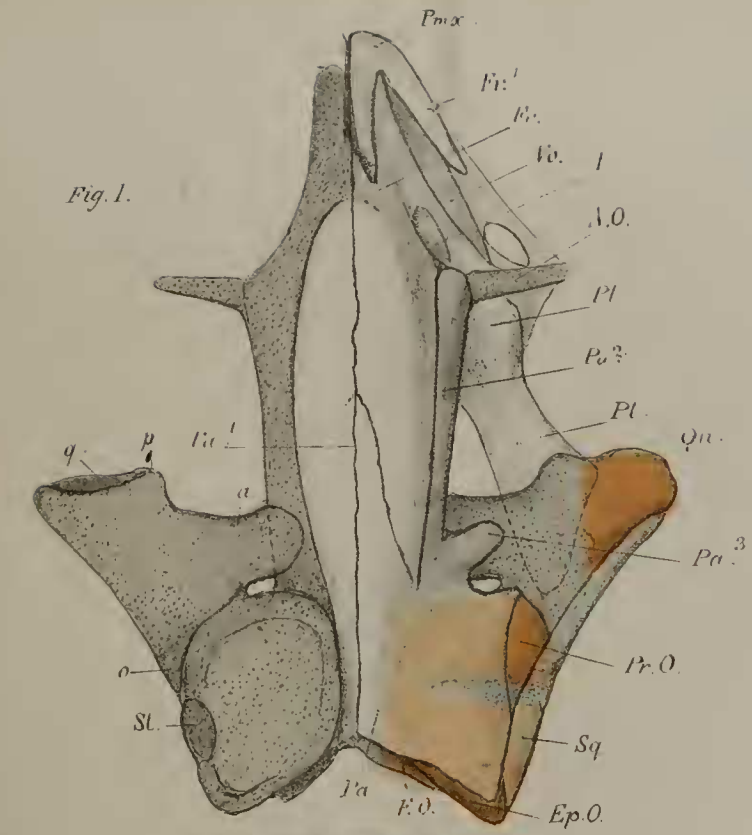

Fig. 1.

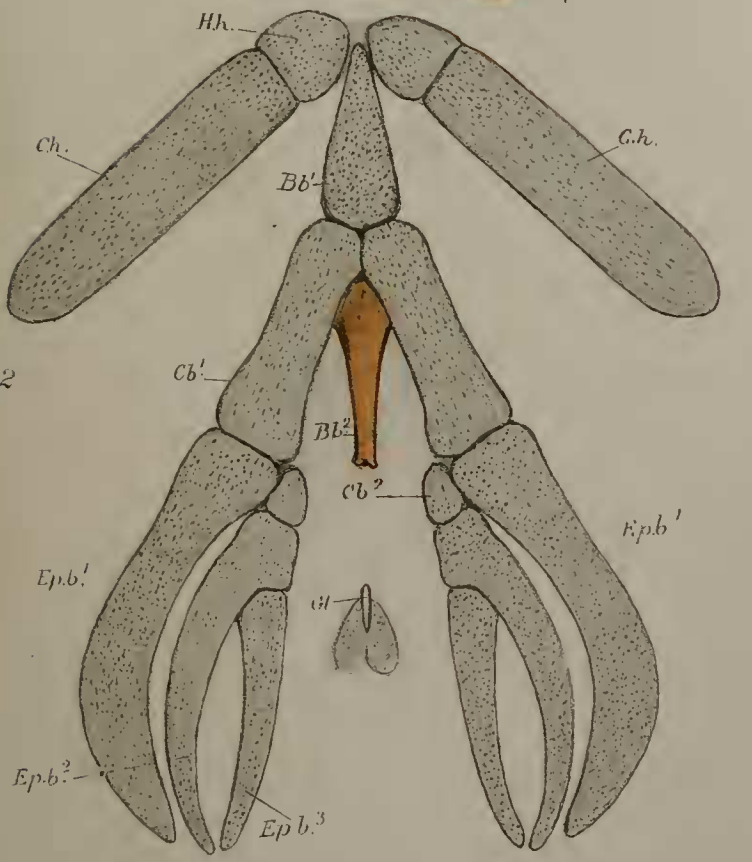

Fig 2

W H Wesley lith.

M & N Hanhart imp

MENOBRANCHUS

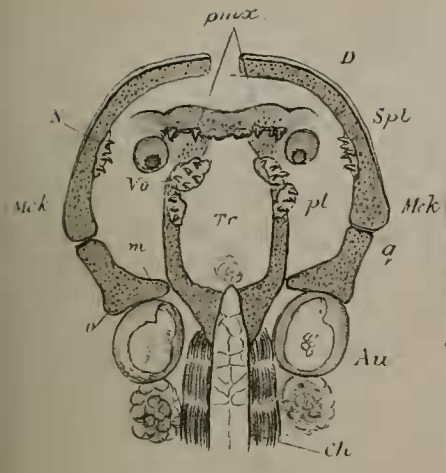

Fig. 1.

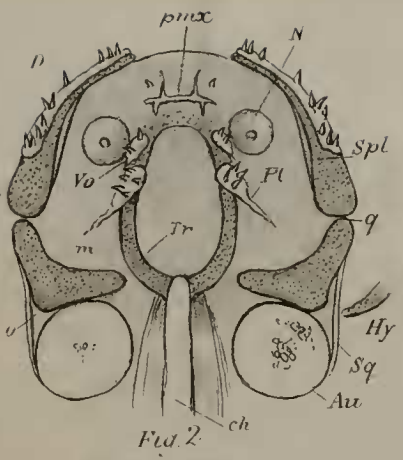

Fig. 2.

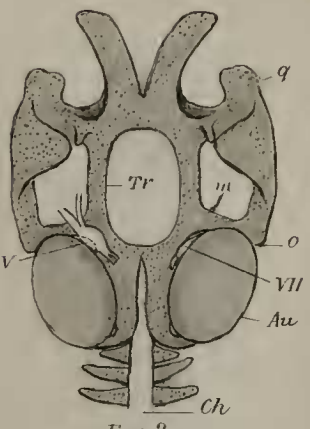

Fig. 3.

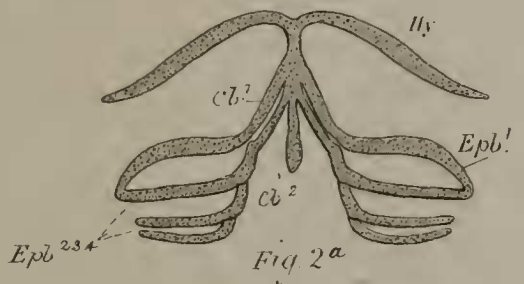

Fig 2a

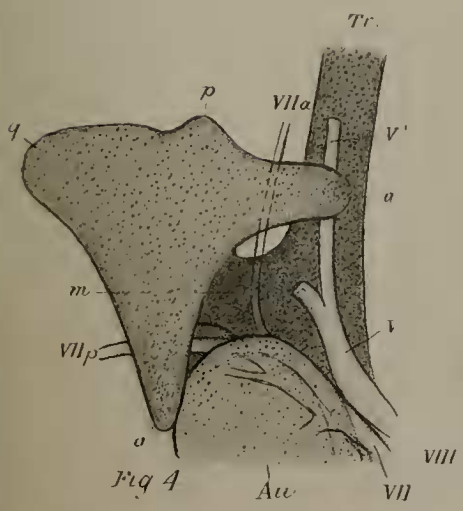

Fig 4

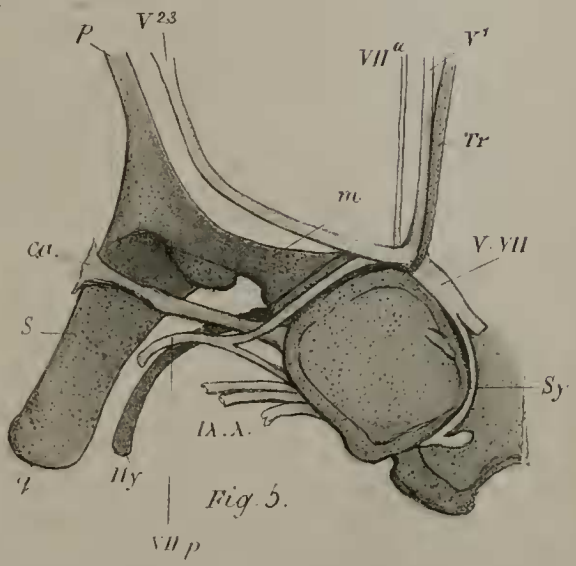

Fig. 5.

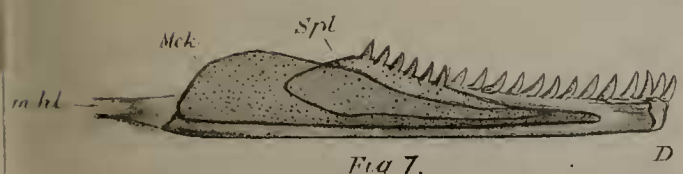

Fig 7.

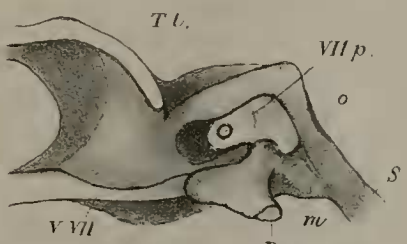

Fig 6

W.H. Wesley lith.

M.&N. Hanhart imp

MENOBRANCHUS. RANA. SIREDON. TRITON.

Fig. 1

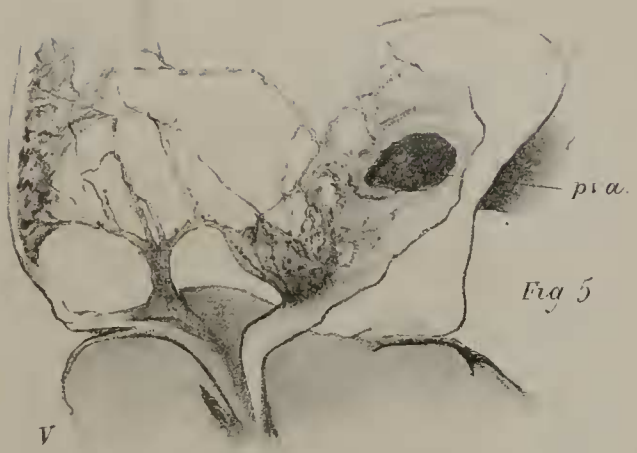

Fig 5

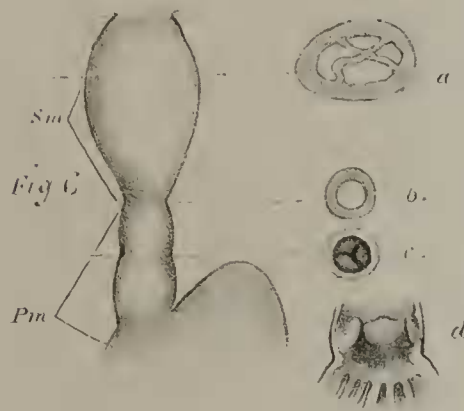

Fig. 2.

Fig 4.

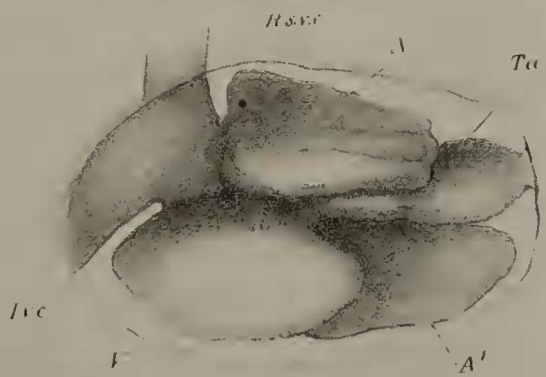

Fig 3.

W H Wesley lith

M & N Hanhart imp.

MENOBRANCHUS.

forwards and downwards." "As in *Menopoma*, the rami of the mandible are not ankylosed together, though the three pieces of each ramus are more closely united than in *Menopoma*. In the skull are distinguishable:—the articular portions of the occipital bone (*b*), which, below, appear not to be separate from the sphenoid (Keilbein) and vomer; above, however, they do not extend to the top of the skull. The parieto-temporal bones (Scheitelschläfenbeine) (*c'*), which are broad and arched, forming laterally the roof of the vestibule. The frontal bones (*c*). The long and bent quadrate bones (*n*). The pterygoid bones (*m*), with their teeth. Between them the great opening for the fifth pair (*x*)." "The nasal bones are wanting. The maxillæ (*k*) and the præmaxillæ (*f*)." A fair figure (tab. vii. fig. 2) accompanies this short notice, from which it is clear that Mayer's "maxillæ" are the vomers, and his "quadrate" the squamosal.

A short description of a skull of *Menobranchus* in the Museum of the Royal College of Surgeons is to be found in the first volume of the 'Catalogue of the Osteological Series,' p. 116. The prominent ossification of the epiotic bears the number appropriated to the "mastoid" by Professor Owen. Fischer ('Anatomische Abhandlungen über die Perennibranchiaten und Derotremen,' 1864) has given an excellent description and figure of the hyoidean and branchial arches of *Menobranchus*. The fullest account, and the best figure, of the skull of *Menobranchus* which I have met with, however, are contained in Van der Hoeven's 'Ontleed- en Dierkundige Bijdragen tot de Kennis van *Menobranchus*,' published in 1867. Van der Hoeven distinguishes the following bones:—the lateral occipitals (exoccipitals *mihi*), the *os sphenoideum* (parasphenoid), the *os pterygoideum* (pterygopalatine), the *os petrosum* (epiotic and opisthotic), the *os parietali-frontale* (parietal), the *os frontale anterius* (frontal), the *os frontale posterius* (prootic), the vomers, the *os tympanicum* (squamosal), and the *os jugale* (quadrato-jugal); in the mandible, the *os dentale* (dentary), and the *os angulare* (splenial).

In his description of the hyoidean and branchial arches, Van der Hoeven agrees with Fischer. As to the manner in which the hyoid is connected with the suspensorium, the latter writer observes that the ascending branch of the hyoidean cornu is connected by ligament with the posterior surface of the "os tympanicum." "In *Hypochthon* a second strong ligament extends from the dorsal apex of the hyoidean cornu to the lower jaw. In none of the other genera [of Perennibranchiata and Derotremata] have I observed this second attachment to the lower jaw. A tendon, which, in *Menobranchus*, runs external to the posterior point of the hyoidean cornu, parallel with the latter, downwards and forwards, belongs to the second portion of the digastric muscle." Nevertheless it will be seen that this second ligament exists no less in *Menobranchus* than in *Proteus*. It is also to be found in *Siren* and *Siredon*. None of the authors cited mentions the cartilaginous framework of the skull*.

The cranium of *Menobranchus* viewed from above (Plate XXX.

* Stannius observes ('Handbuch. Die Amphibien,' p. 38), "Bei den *Proteidea* [*Proteus* and *Menobranchus*] sind die niedrigen Seitenwände der beiden vorder-

fig. 1), presents the form of a pentagon, with a deeply excavated base, and with the angle opposite the base truncated. This truncated angle corresponds with the ends of the premaxillary bones; the lateral angles are occupied by the extremities of the suspensoria, or peduncles to which the mandible is attached; the posterior angles answer to the epiotic processes of the skull of an osseous fish. As these project beyond the level of the occipital foramen, they give rise to the excavated contour of the base of the pentagon. The occipital condyles lie one on each side of and below the occipital foramen; and their slightly convex free surfaces look inwards and backwards. In a side view (Plate XXIX. fig. 1), the skull is seen to be much flattened from above downwards. The suspensorium is inclined downwards and forwards at an acute angle with the cranio-facial axis. The ramus of the mandible is proportionally stout and thick, and the hyobranchial apparatus, though almost wholly cartilaginous, is massive and large relatively to the skull.

The skull consists of a cartilaginous framework, in and upon which certain ossifications have been developed. The former is what is commonly termed the "primordial cranium;" but, as it is preceded by a membranous structure, it would be better termed the "chondrocranium," while the bony skull may be called the "osteocranium."

The *osteocranium* consists of the following bones:—

1. The *exoccipitals* (*E.O*).—These lie on each side of the occipital foramen, and bear the condyles. They do not come into contact either above or below; but the small space left between them is covered by the parietal bones in the former region, and by the parasphenoid in the latter.

2. The *epiotics* (*Ep.O*).—I term these interesting ossifications "epiotic" for brevity's sake. In reality they represent not only the epiotic but the opisthotic ossifications of other Vertebrata. They are conical caps of bone, which are separated by narrow cartilaginous interspaces from the pro-otics (*Pr.O*) in front, but closely unite with the exoccipitals behind and below. As usual, they shelter the posterior part of the organ of hearing; and the *fenestra ovalis*, with its stapes (*St*), is situated in the unossified interspace between the anterior and inferior (or opisthotic) part of the bone and the pro-otic.

3. The *pro-otic* ossifications (*Pr.O*) occupy their ordinary place in the front part of the capsule of the organ of hearing, and are covered above by the parietals (*Pa.*), and externally by the squamosals (*Sq.*).

4. The *parasphenoid* (*P.Sph*) is a very wide and thin bone, which extends from the lower margin of the occipital foramen, posteriorly, to a point beyond the middle of the length of the vomers, anteriorly. It underlies the exoccipitals, the epiotics, and the pro-

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sten Segmente der eigentlichen Schedelcapsel nicht ossificirt," and that they have an abortive cartilaginous antorbital process. He also mentions that the ligament which extends from the præmaxilla to the suspensorium contains particles of cartilage (eingesprengte Knorpel). I have not noticed these in my specimen.

otics behind, while, in front, the vomers underlie it on each side. Its anterior extremity is truncated, and slightly concave forwards.

5. The *vomers* (*Vo*) are much elongated, flattened, broader behind than in front, and have a sigmoid curvature, which is especially manifested by their inner edges. As the vomers come into contact only by their anterior extremities, while their inner edges diverge from one another backwards, there is left between them a wide space, increasing in breadth posteriorly, which is occupied, for the greater part of its extent, by the parasphenoid, but, in front of the truncated anterior termination of this bone, by a part of the chondrocranium. A series of teeth is set along the outer edge of each vomer; and its posterior excavated extremity articulates with the palatine bone.

6. The *parietal* bones (*Pa*) which are broad and flat, cover over the greater part of the epiotic and pro-otic bones. They meet in a median sagittal suture, which is about half as long as the whole skull. Anteriorly, each parietal bone presents three processes. The innermost of these (Pa^1) is the proper continuation of the bone; uniting with its fellow, it gives rise to the anterior half of the sagittal suture, and extends forwards, as a long triangular tongue, which is interposed between the two frontals (*Fr*). The second (Pa^2) and third (Pa^3) processes start from a common root. The inner, very long and slender, runs along the outer edge of the frontal bone, widening a little as it goes, and ends at the posterior boundary of the olfactory foramen (1). The third process (Pa^3) is short, passes downwards and outwards, and rests, in a manner to be described presently, upon a cartilage connected with the suspensorium*.

7. The *frontal bones* (*Fr*), separated behind by the conjoined parietals, unite, in front, in a long frontal suture, and terminate, anteriorly, in pointed processes, which are received between the ascending processes of the premaxillary bones. Between the latter and the olfactory foramen, each frontal is continued into a plate of bone (Fr^1), which lies on the sides of the snout. The anterior, pointed, extremity of this plate fits in between the ascending process of the præmaxilla and the vomer, while its posterior prolongation passes, below the olfactory aperture, to the cartilaginous antorbital process of the skull.

8. A *quadrate* ossification (*Qu*) of irregular form, occupies the distal end of the cartilaginous suspensorium.

9. The *palato-pterygoid* (*Pl. Pt*) is a flattened plate of bone, rounded and spatulate in front, where it articulates with the excavated posterior end of the vomer; truncated behind, where it underlies the suspensorium.

10. The *præmaxillæ* (*Pmx*). These are relatively strong bones, each composed of a horizontal "body" bounding the gape in front, and of a strong ascending process, which passes back on to the top of the skull, at an acute angle with the body of the bone. The "body" tapers off to a point posteriorly; and, in the specimen the skull of

* Professor Owen considers that this process represents "the so-called columella of Lizards" (*l. c.* p. 116).

which I examined, there was no maxilla whatever, mere fibrous tissue connecting the end of the præmaxilla with the outer extremity of the antorbital process, and bounding the posterior nasal aperture externally. But in the skeleton of *Menobranchus* prepared by Hyrtl, now in the Museum of the Royal College of Surgeons, there is, on the right side, a minute bone bearing three teeth, which seems to be a rudimentary maxilla.

11. The *squamosals* (*Sq*) are long slender bones, which extend from near the extremity of the epiotic processes to the articular surface for the mandible on the extremity of the suspensorium. The whole bone is shaped somewhat like a boomerang—the half which lies against the outer side of the suspensorium being bent at an obtuse angle to the half which is connected with the pro-otic, parietal, and epiotic bones, and which runs parallel with the axis of the skull. Where the cranial and suspensorial portions of the bone meet, there is given off, from its posterior margin, a short osseous process, which is directed towards the stapes, covering over the ligamentous fibres which connect the stapes with the suspensorium.

12. The *dentary* (*D*) occupies the whole length of the mandible, rising up on its outer side into a high plate, curving inwards to the symphysis in the middle line, and extending as a shelf, grooved above, beneath Meckel's cartilage, which is received into the groove. Fourteen conical teeth are borne by this bone, and are ankylosed with it.

13. The *splenial* (*Spl*, Plate XXXI. fig. 7) lies on the inner side of Meckel's cartilage, and bears six teeth.

14. The only other ossified member of the cranial, or facial, series present in *Menobranchus* is the second basibranchial (*Bb*^{2}, Plate XXX. fig. 2), a styliform bone, broader in front than behind, which lies in the middle line, and articulates, in front, with the two anterior cerato-branchials (*Cb*^{1}).

The *chondrocranium*, in and upon which the bones now enumerated and described are developed, is a structure of an exceedingly remarkable character. The whole extent of the chondrocranium was ascertained by decalcifying the skull, macerating it afterwards in glycerine containing caustic potash, and then, partly, viewing it as a transparent object, and, partly, examining sections.

In the side walls of the depressed cranial cavity, between the parasphenoid and the second process of the parietal bone (*Pa*^{2}), there lies a rod of cartilage, which, at the anterior boundary of the orbit, is connected with the tapering antorbital process (*A.O*). It then bends inwards (on the inner side of the olfactory sac); and, meeting its fellow in the middle line, the two proceed, parallel with one another, to the end of the snout, their free extremities being embraced by the præmaxillæ.

The antorbital process is separated from the chief mass of this rod, which corresponds with one of the *trabeculæ* of the ordinary embryonic vertebrate cranium, by a line of fibrous tissue. In the internasal region, on the other hand, the anterior ends of the cartilaginous rods (which answer to the cornua of the trabeculæ) become fused together.

Posteriorly, each trabecula passes into the floor of a cartilaginous mass, which is formed, above, by the auditory capsule, and, behind, by the exoccipital, and which has undergone partial ossification. But, in spite of careful search, I could find no cartilage either in the supraoccipital, or in the basioccipital, region, but only a dense connective tissue. In the midst of this, in the basioccipital region, the conical extremity of the notochord is imbedded.

The large oval space included between the trabeculæ, their subauditory continuations, and the inferior and internal edges of the exoccipitals, is floored by fibrous tissue, in which the parasphenoid is developed, just as the roof of the skull is constituted by the fibrous tissue in which the parietals and frontals are formed. The side walls of the cranial cavity are constituted, behind, by the exoccipitals and auditory capsules, in front of these, by the trabeculæ; and, external to them, by the second processes (Pa^2) of the parietal bones.

The suspensorial cartilage presents, anteriorly and below, an oval, concave, articular facet for the articular end of Meckel's cartilage. Just above this, on the inner side, is a small elevation (*p*, Plate XXXI. fig. 4), which is all that represents the palato-pterygoid process of other *Amphibia*. Still higher up, on the inner side, the suspensorium gives off a broad, tongue-shaped, "ascending process" (*a*, Plate XXX. fig. 1), which mounts beneath the "third process" of the parietal bone, and applies itself to the outer side of the trabecular cartilage. The orbito-nasal (ophthalmic) division of the trigeminal nerve (V^1) passes beneath this tongue of cartilage, which therefore, morphologically speaking, ascends higher than the eye, inasmuch as the orbito-nasal nerve, as it passes forwards, runs above the optic nerve (Plate XXIX. fig. 1 and Plate XXXI. fig. 4).

The orbito-nasal nerve actually leaves the skull by a considerable foramen, common to it and the other divisions of the fifth ($V^{2,3}$), which lies between the trabecula internally and below, the pro-otic externally and behind, and the parietal bone above. And this foramen is undivided; but, as the ascending process of the suspensorium passes between the orbito-nasal nerve on its inner and anterior side, and the second and third divisions of the fifth on its outer and posterior side, it looks as if the process in question divided the foramen of exit of the trigeminal nerve into two parts.

The ganglia of the trigeminal and of the seventh nerves are situated, close together, above the trabecula, where it passes into the floor of the auditory capsule—the Gasserian ganglion lying in front of the anterior wall of the capsule, while the ganglion of the seventh, which is very closely connected with the auditory nerve, is placed rather on the ventral side of the anterior end of the capsule (Plate XXXI. fig. 4). Immediately in front of these ganglia, the trabecula is produced externally, and becomes continuous with the suspensorium by the process (*m*), which thus affords the middle and chief attachment of the suspensorium to the skull, and may be named the "pedicle of the suspensorium." Finally, the external and posterior angle of the suspensorial cartilage is produced upwards and backwards, on the exterior of the auditory capsule, with which it is

closely adherent, into an *otic* process (*o*, Plate XXXI. fig. 4). The posterior division of the seventh nerve (which answers to what is commonly called the facial nerve, and may be termed the *hyo-mandibular* division of the seventh) runs directly in front of the auditory capsule, and beneath the otic process of the suspensorium. The anterior division (palatine or Vidian division) of the seventh, on the contrary, passes directly forwards, close to the pedicle of the suspensorium, parallel with the orbito-nasal, and below but external to it.

Meckel's cartilage (*Mck.*) is very thick at its articular end, but rapidly tapers off to a point beyond the coronoid enlargement, to which the elevators of the jaw are attached. The termination of Meckel's cartilage lies at a considerable distance from the symphysial end of the ramus of the mandible (Plate XXIX. fig. 1 and Plate XXXI. fig. 7).

The hyoidean arch has already been well described and figured by Fischer. It is entirely cartilaginous and fibrous. It consists (Plate XXX. fig. 2) of a long and stout *ceratohyal* cartilage (*C.h*), and a small *hypohyal* (*H.h*). The two *hypohyals* are united with one another by fibrous tissue, which represents the *basihyal*. Fibrous tissue connects the proximal half of the ceratohyal with the suspensorium and with the otic region of the skull; and a strong ligamentous band, the *hyo-suspensorial* ligament (*h.s.l*, Plate XXIX. fig. 1), passes from the ceratohyal, at about the junction of its middle and upper thirds, to the middle of the posterior edge of the suspensorium. From this point another strong fibrous bundle, the *suspensorio-stapedial* ligament (*s.s.l*), is continued upwards and backwards to the stapes. The hyo-mandibular branch of the seventh nerve (VII.*p*) passes above this ligament to its distribution, just as it passes above the *columella auris* in the Frog.

Rather above the attachment of the hyo-suspensorial ligament, another strong band of fibrous tissue arises from the ceratohyal, and, passing down on the inner side of the former, is inserted into the angle of the mandible. This may be termed the *mandibulo-hyoid* ligament, and answers to the interopercular element of the osseous fishes' skull (Plate XXIX. fig. 1 and Plate XXXI. fig. 7, *m.h.l*).

The branchial apparatus is composed of two median pieces, the *first* and *second basibranchials* (*Bb*^{1}, *Bb*^{2}); of which the former is cartilaginous, pointed in front, where it is connected with the fibrous representative of the basihyal, broad behind, where it unites with the two ceratobranchials (*Cb*^{1}).

The second basibranchial is the only portion of the branchial apparatus which is ossified, and has been described above.

The stout *anterior ceratobranchials* (*Cb*^{1})* meet in the middle line, between the first and second basibranchials. The broad, dorsal end of each articulates with the correspondingly broad, ventral end of the first *epibranchial* (*Ep.b*^{1}), which is curved, and tapers to a point at its dorsal extremity.

* Fischer (*l. c.* p. 19) considers that these represent the anterior and posterior ceratobranchials coalesced; but I see no evidence that such a process has taken place.

The *posterior ceratobranchial* (*Cb*^{2}) is a mere nodule of cartilage, which is connected, externally, with the anterior ceratobranchial and first epibranchial, and on its dorsal side articulates with the enlarged ventral end of the second epibranchial (*Ep.b*^{2}). The slender, slightly curved, third epibranchial (*Ep.b*^{3}) articulates with the enlarged ventral end of the second. There is no trace of a fourth epibranchial.

On comparing the cranium of *Menobranchus* with that of other *Amphibia*, one is at once struck (as Van der Hoeven has already remarked) by its many resemblances to that of *Proteus*.

In *Proteus*, the skull is similarly elongated and narrow, especially in the nasal and maxillary regions. The epiotic processes are prominent; and the suspensorium is inclined downwards and forwards at a like angle. The nasal, maxillary, and jugal bones are absent in *Proteus*, as in *Menobranchus*; the vomers and the palato-pterygoids have a similar disposition. In the general form and mode of attachment to the skull, in the rudimentary condition of the posterior ceratobranchial, in the presence of only three epibranchials, the hyoid and branchial apparatuses of *Proteus* closely accord with those of *Menobranchus*, though those of *Proteus* are much more extensively ossified. In both genera the epiotic and opisthotic regions ossify and give rise to a distinct bone, the summit of which forms the epiotic process. Moreover, the chondrocranium of *Proteus* is, in all essential respects, similar to that of *Menobranchus*, though the trabeculæ are partially ossified where they lie between the nasal sacs.

In possessing prominent epiotic ossifications, which project as strong conical processes from the occipital region of the skull, *Menobranchus* and *Proteus* differ from all other existing Amphibia, and agree with the extinct Labyrinthodonts *. In the absence of the fourth epibranchial, *Proteus* and *Menobranchus* differ from *Siren*, *Siredon*, *Menopoma*, and *Amphiuma*. In the rudimentary condition of the second ceratobranchial they approach *Amphiuma*, in which this element is absent.

In the structure of the chondrocranium, *Menobranchus* and *Proteus* differ from the Frog and from *Siredon* (the only Amphibia in which the chondrocranium has as yet been thoroughly examined) in the persistence, throughout life, of a far more embryonic type of structure. In fact, the skull of even the Lamprey is, in some respects, less embryonic than that of *Menobranchus*, the floor and roof of the occipital region having acquired a more complete chondrification in the Marsipobranch.

It is to the embryonic condition of the vertebrate skull, especially in the class to which *Menobranchus* belongs, that we must have recourse for an explanation of the structure of its primordial cranium.

If the cartilaginous skull of a tadpole, before it has lost its external gills, be compared with the persistent chondrocranium of *Menobranchus*, the general correspondence of the two becomes obvious (Plate XXXI. fig. 3). There is a very large pituitary space, bounded by the trabeculæ (*Tr*) at the sides. In front, the latter

* *Siren* and *Amphiuma* have epiotic processes of a different form.

converge and coalesce into the internasal prolongations, which give rise to the mesethmoid of the adult Frog. But, in the tadpole, at this stage of its development, the "parachordal cartilages," which have been developed at the sides of the notochord, have united with one another and with the trabeculæ, and thus the pituitary space is much shorter than in *Menobranchus*. The cartilaginous skull of a tadpole of this age, in fact, has already obtained a higher development than it ever reaches in *Menobranchus*.

The auditory capsules are rounded behind, in the tadpole, and do not extend backwards as pointed processes beyond the level of the exoccipitals; in which respect the tadpole's skull is more frog-like, and less fish-like, than that of the adult *Menobranchus*.

In the tadpole's skull, the suspensorium is attached to the trabecula of its side, close to the point at which the latter passes into the parachordal cartilage. The cartilaginous band (*m*, Plate XXXI. fig. 3), in fact, which passes into the trabecula, is the dorsal end of the mandibular arch, and corresponds with the pedicle of the suspensorium in *Menobranchus*, having the same relations to the ganglia and branches of the fifth and seventh nerves. In the adult Frog, the pedicle of the suspensorium has been carried outwards by the lateral growth of the auditory region of the skull, and is articulated by a joint* with the cartilage of this region, close to the outer extremity of the transverse arm of the parasphenoid. The inner process of the pterygoid lies on its ventral side, closely applied to it.

The elbow (*o*) by which the suspensorium of the tadpole abuts against the anterior and external face of the auditory capsule evidently corresponds with the *otic process* of the suspensorium of *Menobranchus*. In the adult Frog, the suspensorium, which is ossified only at its mandibular end, forks, at its cranial end, into two branches or crura, the interspace between which is filled by fibrous tissue (Plate XXXI. fig. 6). These crura, and the fibrous tissue which connects them, form the front wall of the tympanic cavity: the dorsal crus, which answers to the otic process, passes into the *tegmen tympani*, or roof of the tympanum, which is furnished by the outgrowth of the auditory capsule; the ventral crus is the pedicle of the suspensorium just mentioned.

Passing between the two crura (as Dugès long since pointed out) the seventh nerve enters the tympanum, closely applied to the inner wall of which (but not included in any Fallopian canal) it passes, above the level of the *fenestra ovalis*, over the *columella auris*. It takes, in fact, exactly the same course as in a mammal, except that it runs round the auditory capsule, instead of being included in a canal by the growth of the latter round it.

Some remarkable consequences appear to flow from the observed metamorphoses of the cranial end of the mandibular arch in the Frog. If the ossification which has already set in in the mandibular

* My friend Mr. Parker, F.R.S., in his remarkable memoir on "The Structure and Development of the Skull of the Common Frog" (Philosophical Transactions, 1871), has given a different account of the origin of this singular articulation; but I believe I may say that he now agrees with me.

end of the suspensorium extended up into its dorsal crus, or otic process, we should have a quadrate bone, exactly like that of a Chelonian reptile. On the other hand, if the ventral crus became ossified continuously with the inner process of the pterygoid, and the basisphenoid were developed, we should have such a connexion of the pterygoid with the basisphenoid as exists in many Lizards and Birds *. Whence it appears to follow, that this part of the pterygoid represents the, morphologically, dorsal end of the mandibular arch, and that the dorsal end of the os quadratum is a secondary development of that arch, which becomes applied to the outer face of the auditory capsule.

The articular surfaces for Meckel's cartilage are corresponding points in both *Menobranchus* and the Frog's tadpole; but the *palato-pterygoid* process (*p*), which is rudimentary in the *Menobranchus*, and far apart from the antorbital process (*A.O*) (the intermediate space being occupied only by membrane, bone, and connective tissue) is, though equally short, completely fused with the antorbital process in the tadpole.

There remain to be compared the orbital process (*Or.*) of the suspensorium of the tadpole and the ascending process (*a*) of the suspensorium of *Menobranchus*.

It is clear that the orbital process, if it grew upwards and inwards towards the dorsal side of the trabecula, might very well cover in the orbito-nasal branch of the fifth nerve, as it actually does in *Menobranchus*. But then it would also cover in the third division of the fifth and the levator muscle of the mandible, internal and anterior to which it lies in *Menobranchus*.

For these reasons I do not identify the "orbital process" of the tadpole's suspensorium with the "ascending process" of that of *Menobranchus*†, though in some respects they are analogous.

In the tadpole, the tissue on each side of the notochord is so largely chondrified that it has formed a complete floor to the occipital and interauditory region of the skull, has roofed in the occipital region, and has coalesced with the auditory capsules; and the skull has attained this condition at a much earlier stage than that to which reference is here made ‡.

But I know of no condition of the skull of the Frog which is

* Stannius ('Handbuch d. Zootomie,' 2te Auflage: "Die Amphibien," p. 36) remarks, in giving the general characters of the skull in the "Amphibia Dipnoa," that the more or less cartilaginous pterygoid arcade in these animals is always connected with the rest of the skull in three places:—1, with the suspensorium; 2, with the sphenoidal region of the skull; 3, with the lower part of the anterior and outer wall of the orbital cavity. Of these "the connexion with the sphenoidal region answers to the articulation of the pterygoid with the basisphenoid in most *Streptostylica* [Lacertilia and Ophidia], Birds, &c.; the connexion with the lower part of the anterior wall of the orbit corresponds with the union of the pterygoid with the maxilla and jugal by means of an *os transversum* in *Streptostylica* and Crocodiles."

† A corresponding process exists in *Proteus*, *Siredon*, *Menopoma*, and *Amphiuma*.

‡ See my Croonian Lecture (Proc. Roy. Soc. 1858), and, for full details, Mr. Parker's Memoir in the 'Philosophical Transactions' for 1871, already referred to.

quite so instructive in its bearing on that of *Menobranchus* as is the skull of a *Triton* about the period at which it leaves the egg * (Plate XXXI. figs. 2, 2*a*), or that of a larval Axolotl (Plate XXXI. fig. 1).

Here the notochord occupies the centre of the future *basis cranii*, terminating in front in a rounded apex. The parachordal tissue exhibits no trace of chondrification; but it is very interesting to observe, on each side of it, the indication of an intermuscular septum, separating two myotomes, and thus indicating, so far, a segmentation of this region.

The auditory capsules are spherical sacs, which lie, quite isolated, on each side of the notochord, at some distance from it, and are not yet chondrified. The trabeculæ abut against the notochord posteriorly, but are wholly separate from any other structure. In front, they have begun to coalesce and to give rise to the broad internasal plate which is characteristic of the Salamandridea. On each side of them are seen the nasal sacs, with the minute posterior nares opening into the cavity of the mouth. Behind, and external to, each trabecula is a stout cartilaginous rod, which obviously represents the suspensorium; but the dorsal end of this cartilage (*m*), though it lies close to the trabecula, has not yet coalesced with it, and the mandibular arch is therefore quite free. The external angle (*o*) corresponds in its relation to the auditory capsule with the part similarly marked in the Frog's tadpole and in *Menobranchus*. At (*q*) is the articular surface for Meckel's cartilage (*Mck*); but neither "orbital," "ascending," nor "palato-pterygoid" processes are as yet developed.

The hyoidean arch (*Hy*, figs. 2, 2 *a*) is as distinct and independent as are the mandibular and trabecular arches; it is an unjointed cartilage with a pointed dorsal end, which lies close to the auditory capsule. At its ventral extremity it coalesces with its fellow; while, behind, it is continuous with a median cartilage, which represents the basibranchials and ends in a long spatuliform style. From the sides of the median cartilage two ceratobranchials proceed, and are continued, the anterior into the first epibranchial, the posterior into the three other epibranchials. None of these parts are distinctly articulated, the future joints being, at most, faintly indicated. Sundry ossifications are visible in the fibrous tissue contiguous to the cartilages; thus the dentary (*D*) and splenial (*Spl*) pieces of the mandible, the squamosals (*Sq*), and the præmaxillæ (*Pmx*) (already one bone) have made their appearance.

The vomers (*Vo*), each of which bears two teeth, lie far apart, on the inner side of each nasal opening, and beneath the anterior end of the trabecula. Behind these are two dentigerous ossifications of the fibrous roof of the mouth, broad and rounded in front, but drawn out behind into a sort of tail, which is directed towards the suspensorium, though it does not reach the latter. These bones correspond with the anterior moieties of the palato-pterygoids of *Menobran-*

* The observations on which the following statements respecting *Triton* rest, were made in 1858; but I did not publish them, as I could not then obtain the materials for completing the history of the development of the Triton's skull. Perhaps I shall be more fortunate this spring.